Visual Media Reasoning – VMR

aka "The Vision Factory"

Rapid, Automated Analysis of Enemy Photos

"Who, What, Where, When is that?"

Mr. Michael Geertsen, I2O Program Manager

August 31, 2011

Disclaimer

- This presentation is provided solely for information and planning purposes
- The Industry Day does not constitute a formal solicitation for proposals or proposal abstracts
- Nothing said at Industry Day changes the requirements set forth in a BAA
- BAA supersedes anything presented or said at Industry Day

Visual Media Reasoning (VMR) Industry Day

Final Agenda		
7:30am – 9:00am	***Registration and Breakfast***	
9:00am – 9:15am	*Welcome*	*Mr. Michael Geertsen* *DARPA/I2O Program Manager*
9:15am – 9:45am	*Security*	*DARPA Security Representative*
9:45am – 10:15am	*Contracting*	*DARPA Contracting Representative*
10:15am– 10:30am	***Break***	
10:30am – 11:30am	*VMR Overview*	*Mr. Michael Geertsen* *DARPA/I2O Program Manager*
11:30am – 12:00pm	*VMR Q&A*	*All*
12:00pm – 1:15pm	***Lunch***	
1:15pm – 2:15pm	*Real World Perspective* • *Technology Presentation (15 min.)* • *Intel/Gov't Customer Presentation (30 min.)* • *Technology Presentation (15 min.)*	*Invited Outside Speakers*
2:15pm – 3:00pm	*Critical Issues Breakout*	*All*
3:00pm – 3:15pm	***Break***	
3:15pm – 3:45pm	*Critical Issues Q&A*	*All*
3:45pm – 4:30pm	*Structured Teaming Opportunity*	*All*

Capital Conference Center
Arlington, Virginia
August 31, 2011

Security Briefing

Contracting Briefing

VMR – Program Manager Perspective

VMR Overview

Program Technical Areas / Mgmt

Q and A

“The bad guys love taking photos...”

Senior Chief, USN
Five Deployments

Adversaries often take photos and videos to claim responsibility for events, associations, or illustrate capabilities…

A wealth of unexplored data stuck in huge databases…

Can we turn unstructured, ad hoc photos and videos into true “visual intelligence”?

Self-inflicted information overload is bad enough...

If you thought **managing our own flood** of UAV, video and satellite imagery was tough,

... try dealing with **adversary-taken imagery!**

Structured Content **Known platforms, high integrity**		**Unstructured Content** **Multiple devices, unknown integrity**
+	Growing, uncontrollable volume	+
+	Stills and video	+
+	Known author, time, and place	-
+ -	Spontaneous	+
+ -	Denied areas	+
-	Denied events	+
-	Audio	+

From theater...

What could we learn from this image?

Who, What, Where, When

Who

- ...committed a certain act; was at an event
- ...possessed or transported contraband
- ...was training

What

- ...specific vehicles were used
- ...unique weapons someone owned
- ...tools or devices were involved

Where

- ...the safe house is located
- ...the training occurs
- ...the hostage was filmed

When

- ...the video was taken
- ...the bomb was planted
- ...the claim was made

Link Analysis

- Where else did I see him?
- Is that the same car?
- What other photos do we have of that neighborhood?

Is the time right to try and automate a solution?

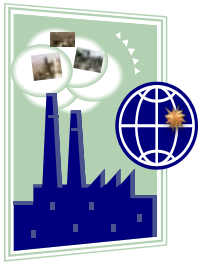
Four tech trends have just now matured to make it feasible:

Expertise
Multiple, mature algorithms

40 + years of Image Understanding & Computer Vision advances

Data
Detailed pattern matching

Increasing availability of massive photo and LiDAR datasets



How can we integrate these?

Software
Flexible platform independence

Modular software architectures (API's, 3-Tier, HTML5)

Hardware
Near real-time speed

Powerful hardware clouds and new Graphics Processing Unit (GPU) techniques

The idea: **A "Vision Factory"**

A multi-purpose software application accessible from **mobile devices, laptops and desktops**...

Frontline personnel upload a digital photo/video ...

Any common format:
.jpg .bmp .gif .png .tif etc.

- **1989 Honda 250 XL**
- **Mr. Al-Fulani**
- **15.966 N 48.788 E**

... and receive back mission-relevant information.

Intelligent "Visual Search"

The Vision Factory: **Building It**

A four-part modular software architecture designed to:

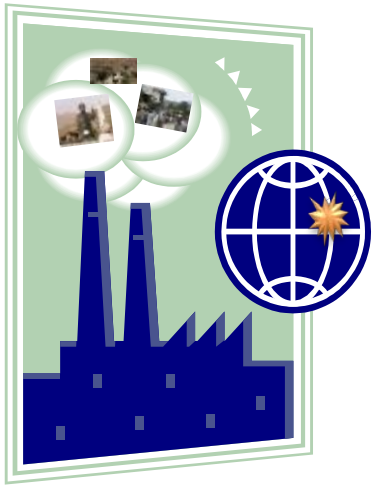
- Optimize development
- Attract broad user audience
- Evolve with new innovations and data

Image Processing Techniques

- SIFT
- OpenCV
- CUDA
- 3D Extrusion

...many more

Open A.P.I.'s



"Shop Foreman" meta-algorithm

1. Evaluates the image
2. Prepares the image
3. Plans best approach
4. Manages production

User Interface

1. "Friendly"
2. Lightweight
3. Human-in-the-loop

Open A.P.I.'s

Reference Datasets

- DoD-wide
- Agency-specific
- Public domain

...many more

How would a Vision Factory process such an image?

Walk-through sample process...

User Interface

If needed, ask user for help...

"Shop Foreman" meta-algorithm

Pre-process
- Too blurry?
- Too dark?
- Metadata?
- User clues?

Adjust

Recognize features
- Buildings
- Cars
- Foliage
- Terrain
- etc.

Create signatures
- Point Cloud,
- Polylines
- 3D objects
- Histogram
- etc.

Techniques

Apply signatures against datasets

Iterate using dependencies

Interim result w/probability

Present best result to user

Datasets
- Haloe
- Theater
- DTED
- Structures
- Aerial
- Faces
- ...many others

User Interface | **Techniques** | **Datasets** | **User Interface**

VMR – Program Manager Perspective

VMR Overview

Program Technical Areas / Mgmt

Q and A

Program Scope

Four Technical Areas

	Multiple Awards Possible?
TA1 - Product Integration	Yes - Competing
TA2 - Algorithms/Datasets/APIs	Yes - Cooperative
TA3 - System Testing, Performance Validation, and User Experience	Yes - Cooperative
TA4 - Enabling Technologies	Yes

Four – 12 month phases

TA1 – Product Integration

"Shop Foreman" AI, human-machine interaction, user interface, plus open architecture for integration with other DoD systems	
Assumptions: • APIs developed by TA2 • Modular, open architecture, including user interface, data interface, etc. • Cloud-based; lightweight clients • Any vision algorithm development must be justified in context of open architecture and TA2 efforts • Data will be provided by Gov't/TA2 • First N months – TA2 will be work in progress	Discussion points: • Meta-controller • Open architecture • User Interface / user access • Cloud implementation

TA2 – Algorithms, Datasets and APIs

Identifying, optimizing and creating (as necessary) appropriate image understanding techniques and DoD/IC/public reference datasets plus open APIs for both	
Assumptions: • Data access provided by Gov't • No pre-defined set of algorithms* • New algorithm development "as necessary", determined from TA1 (mostly) • Data set API will need to consider multiple classification levels	Discussion points: • Dataset types and variety • Dataset "auto-indexing" • Representation datasets • Classification levels

* Potential seedling to provide a survey of the "algorithm landscape" will be made available

Technical Area 3 – Testing, Performance and UX

System and component testing, performance evaluation, usability and user group management	
Assumptions: • Performance criteria agreed to by the User Group and TA1 • No TA3 Performer can be involved in TA1 or TA2	Discussion points: • Performance criteria • Role of the User Group • Automated testing

Technical Area 4 – Enabling Technologies

Exploration and creation of core technologies (not necessarily related to computer vision) in parallel with the system development, e.g. fast point cloud query methods	
Assumptions: • TA4 is outside the critical path of the other TAs	Discussion points: • Innovative approaches • Collaboration with TA1 – TA3 • Relevant non-vision technology OK

How the Program will be Managed

- Agile, virtual team of peers
- Team culture – cooperation, user-driven, sustainability
- The DARPA PM will act as the prime integrator - “coach”

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Q and A

Please write your questions on a card and pass them to the aisle…

VMR – Real World Perspective

Michael Gerlek

U.S. Army Sergeant Walter Paz

Kevin Barone

Critical Issues Breakout

Form small groups, share opinions, select presenter, brief all in Q&A

Areas to consider:

1. Highest risk technical areas
2. Program structure “gotchas”
3. Unintended consequences – either people issues or technical issues

To start, check under your chairs for puzzle pieces….

Critical Issues Q and A

Group representatives please summarize...

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